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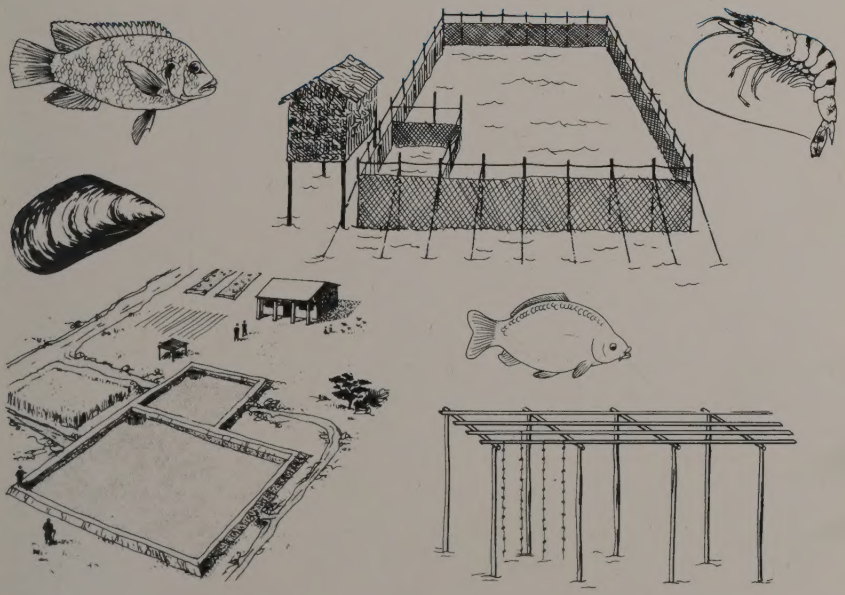

AQUACULTURE DEVELOPMENT

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AQUACULTURE DEVELOPMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1997

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PREPARATION OF THIS DOCUMENT

The present guidelines have been prepared by the Fisheries Department, with the collaboration of the Legal Office of FAO, on the basis of comments and suggestions received on the draft guidelines for responsible aquaculture development, which were provided for information to the Technical Consultation on the Code of Conduct for Responsible Fishing, Rome, 26 September - 5 October 1994. In finalizing this document, due consideration was given to additional comments and suggestions received and to related expert views voiced at major international meetings and/or publications. The document has been prepared under the coordination of R.L. Welcomme and U. Barg of the Inland Water Resources and Aquaculture Service, and includes additional experiences gained from other staff's work related to recent trends and developments associated with the aquaculture sector. M. Lizárraga, A. van Houtte, C. Lería, W. Edeson, K. Rana, R. Grainger, A. Bonzon, D. Gréboval, E. Ruckes, C. Lima Dos Santos, J. Kapetsky, H. Naeve, Z. Shehadeh, D. Bartley, R. Subasinghe, A.Tacon and F. Henderson assisted and contributed to this effort in various ways.

It has to be stressed that these guidelines have no formal legal status. They are intended to provide general advice in support of the implementation of Article 9 - ***Aquaculture Development*** - of the Code of Conduct for Responsible Fisheries. The document provides the reader with general annotations to the provisions of Article 9 which are meant to serve only as general guidance, and should be taken as suggestions or observations for consideration when addressing issues related to the implementation of the provisions of the Code of Conduct for Responsible Fisheries. Furthermore, any eventual differences in the terminology employed should not be understood as intending reinterpretation of the Code. It should also be remembered that since the guidelines are intended to be flexible and capable of evolving as circumstances change, or as new information becomes available, these guidelines may be further revised and complemented by other guidelines, notes, etc. on specific issues, and some of them are already under elaboration as indicated in the text of this document. In this regard, readers are invited to collaborate with FAO providing any information on relevant technical, policy or legal issues which might be useful in updating, evaluating and improving this document as well as in developing more specific guidance documentation aiming at the promotion of responsible development of aquaculture in order to contribute to sustainable food supply.

Distribution:

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FAO Fisheries Department.
Aquaculture development.
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ABSTRACT

Aquaculture is one of the fastest growing food production systems in the world, with the bulk of its output currently being produced within developing countries, and with expectations for aquaculture to continue its contributions to food security and poverty alleviation. The vast majority of aquaculture practices around the world have been pursued with significant nutritional and social benefits, and generally with little or no environmental costs. However, it is essential for current efforts aiming at the future success of aquaculture in both developing and developed countries, that potential social and environmental problems are duly addressed in order to ensure that aquaculture develops sustainably.

This document provides annotations to the Principles of Article 9 of the Code of Conduct for Responsible Fisheries. These annotations are meant to serve as general guidance, and should be taken as suggestions or observations intended to assist those interested in identifying their own criteria and options for actions, as well as partners for collaboration, in support of sustainable aquaculture development.

Given the diversity in aquaculture and the sometimes different perceptions of "sustainability", more balanced and informed approaches are required to address developmental and environmental issues at any given location. Commitment for collaboration, constructive dialogues among responsible partners, and participation of aquafarmers and their communities are important when assigning responsibilities for sustainable development of aquaculture.

Providing an enabling environment for sustainable development in aquaculture is the responsibility of people in governments and their institutions, social and natural scientists, media, financial institutions, special interest groups, including social and private sector associations, as well as of aquaculture producers, manufacturers and suppliers of inputs, processors and traders of aquaculture products. Commitment to understanding, fairness and responsible attitudes in consultations and negotiations between countries or regions will also help sustainable aquaculture development.

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Background

1. From ancient times, fishing has been a major source of food for humanity and a provider of employment and economic benefits to those engaged in this activity. However, with increased knowledge and the dynamic development of fisheries, it was realized that living aquatic resources, although renewable, are not infinite and need to be properly managed, if their contribution to the nutritional, economic and social well-being of the growing world's population was to be sustained.

2. The adoption in 1982 of the United Nations Convention on the Law of the Sea provided a new framework for the better management of marine resources. The new legal regime of the oceans gave coastal States rights and responsibilities for the management and use of fishery resources within their EEZs, which embrace some 90 percent of the world's marine fisheries.

3. In recent years, world fisheries have become a dynamically developing sector of the food industry, and many States have striven to take advantage of their new opportunities by investing in modern fishing fleets and processing factories in response to growing international demand for fish and fishery products. It became clear, however, that many fisheries resources could not sustain an often uncontrolled increase of exploitation.

4. Clear signs of over-exploitation of important fish stocks, modifications of ecosystems, significant economic losses, and international conflicts on management and fish trade threatened the long-term sustainability of fisheries and the contribution of fisheries to food supply. Therefore, the Nineteenth Session of the FAO Committee on Fisheries (COFI), held in March 1991, recommended that new approaches to fisheries management embracing conservation and environmental, as well as social and economic, considerations were urgently needed. FAO was asked to develop the concept of responsible fisheries and elaborate a Code of Conduct to foster its application.

5. Subsequently, the Government of Mexico, in collaboration with FAO, organized an International Conference on Responsible Fishing in Cancún in May 1992. The Declaration of Cancún endorsed at that Conference was brought to the attention of the UNCED Summit in Rio de Janeiro, Brazil, in June 1992, which supported the preparation of a Code of Conduct for Responsible Fisheries. The FAO Technical Consultation on High Seas Fishing, held in September 1992, further recommended the elaboration of a Code to address the issues regarding high seas fisheries.

6. The One Hundred and Second Session of the FAO Council, held in November 1992, discussed the elaboration of the Code, recommending that priority be given to high seas issues and requested that proposals for the Code be presented to the 1993 session of the Committee on Fisheries.

7. The Twentieth Session of COFI, held in March 1993, examined in general the proposed framework and content for such a Code, including the elaboration of guidelines, and endorsed a time frame for the further elaboration of the Code. It also requested FAO to prepare, on a "fast track" basis, as part of the Code, proposals to prevent reflagging of fishing vessels which affect conservation and management measures on the high seas. This resulted in the FAO Conference, at its Twenty-seventh Session in November 1993, adopting the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which, according to FAO Conference Resolution 15/93, forms an integral part of the Code.

8. The Code was formulated so as to be interpreted and applied in conformity with the relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea, 1982, as well as with the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995, and in the light of, *inter alia*, the 1992 Declaration of Cancún and the 1992 Rio Declaration on Environment and Development, in particular Chapter 17 of Agenda 21.

9. The development of the Code was carried out by FAO in consultation and collaboration with relevant United Nations Agencies and other international organizations, including non-governmental organizations.

10. The Code of Conduct consists of five introductory articles: Nature and Scope; Objectives; Relationship with Other International Instruments; Implementation, Monitoring and Updating and Special Requirements of Developing Countries. These introductory articles are followed by an article on General Principles, which precedes the six thematic articles on Fisheries Management, Fishing Operations, Aquaculture Development, Integration of Fisheries into Coastal Area Management, Post-Harvest Practices and Trade, and Fisheries Research. As already mentioned, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas forms an integral part of the Code.

11. The Code is voluntary. However, certain parts of it are based on relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea of 10 December 1982. The Code also contains provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties, such as the Agreement to Promote Compliance with Conservation and Management Measures by Fishing Vessels on the High Seas, 1993.

12. The Twenty-eighth Session of the Conference in Resolution 4/95 adopted the Code of Conduct for Responsible Fisheries on 31 October 1995. The same Resolution requested FAO *inter alia* to elaborate as appropriate technical guidelines in support of the implementation of the Code in collaboration with members and interested relevant organizations.

1. Introduction

1.1 Context and scope

"States should consider aquaculture, including culture-based fisheries, as a means to promote diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment and on local communities are minimized."

Article 6.19
General Principles
Code of Conduct for Responsible Fisheries

Aquaculture is currently one of the fastest growing food production systems in the world. Most of global aquaculture output is produced in developing countries, and, significantly, in low-income food-deficit countries. With stagnating yields from many capture fisheries and increasing demand for fish and fishery products, expectations for aquaculture to increase its contribution to the world's production of aquatic food are very high, and there is also hope that aquaculture will continue to strengthen its role in contributing to food security and poverty alleviation in many developing countries. However, it is also recognized that aquaculture encompasses a very wide range of different aquatic farming practices with regard to species (including seaweeds, molluscs, crustaceans, fish and other aquatic species groups), environments and systems utilized, with very distinct resource use patterns involved, offering a wide range of options for diversification of avenues for enhanced food production and income generation in many rural and peri-urban areas.

In view of the significant nutritional, social, economic and environmental benefits, which generally can be associated with most existing aquaculture practices, and the good prospects for further development and expansion of the sector, it is important for efforts aiming at the sustainable development of aquaculture that potential social conflicts and environmental problems are minimized. Aquaculture, like all terrestrial farming systems, is to face a number of challenges including increasing competition for limited resources, such as water, land and feed inputs, environmental degradation of resources utilized or needed, lack of recognition as legitimate resource user, lack of institutional and legal support, over-regulation and, recently, harmful publicity, which resulted from relatively few cases of environmental degradation and social disruption caused by certain types of aquaculture practice.

From the economic standpoint, the major constraints to be addressed while promoting the development of aquaculture will be to reduce externalities. Two broad categories of externalities will need to be considered. First, those externalities generated by activities which create unsuitable conditions for others, such as various forms of pollution or destructive impacts of human activity and which are not compensated for or paid by those responsible for the external effect. Second, the externalities generated by competition in access to a limited resource (for example, water or a segment of the coastal area) and which lead to economic inefficiency as more capital and labour are invested while obtaining less benefits. Care should be taken to reduce externalities to limit, to acceptable levels, negative impact or economic wastes resulting from

aquaculture activity, as well as resulting from the decision or action of other economic agents on aquaculture activity.

While the Code of Conduct for Responsible Fisheries stipulates actions to be taken by States, it is also meant to address persons, interest groups or institutions, public or private, who are involved in or concerned with aquaculture. Government authorities will increasingly have a key role to play in enhancing effective collaboration with and among many players, in order to promote sustainable development of aquaculture. Responsibilities for sustainable aquaculture development will need to be shared among government authorities, aquafarmers, manufacturers and suppliers of aquaculture inputs, processors and traders of aquaculture products, financing institutions, researchers, special interest groups, professional associations, non-governmental organizations, and others.

A major task here is to generate commitment for constructive dialogues and effective collaboration, among partners in aquaculture development, at local, national, and international levels. Collaboration for sustainable aquaculture development will need to recognize the diversity of aquaculture practices as well as the diversity of the political, social and economic conditions in which they take place, or will be taking place. The capacity of developing countries to implement the recommendations of the Code of Conduct for Responsible Fisheries should be duly taken into account (see the Code's Article 5 - Special Requirements of Developing Countries). It is important that circumstances and conditions in developing countries are fully recognized and addressed, in terms of their needs for financial and technical assistance, technology transfer, training and scientific cooperation, in order to enhance their ability to implement aquaculture-specific recommendations of the Code.

The present document cannot, and is not intended to, address all challenges and issues associated with current aquaculture developments, their sustainability and the needs and means for enhanced collaboration and responsible actions of all actors involved. Due to the very diverse nature of aquaculture practices around the world, it can only provide annotations to the Principles of Article 9 - Aquaculture Development - of the Code of Conduct for Responsible Fisheries. These annotations may only serve as general guidance, and should be taken as suggestions or observations intended to assist those interested in identifying their own criteria and options for actions, as well as partners for collaboration, in support of sustainable aquaculture development, and in recognizing the sometimes very different needs and perceptions which may be associated with sustainable development and aquaculture production.

More detailed guidelines on specific issues and topics covered by Article 9 of the Code are in preparation, or will be developed in the future, by the FAO Fisheries Department, in collaboration with interested partners. There may be a need to provide specific guidelines on certain types of aquaculture systems, on selected species groups or commodities, or on aquaculture development efforts in certain environments or regions. It should be noted that, in addition to FAO's efforts, there are numerous local, national, regional and international initiatives promoting sustainable development of aquaculture. FAO encourages collaboration in this regard, as well as in relation to the implementation of the Code's principles. It is hoped that collaboration in the preparation and

implementation of specific guidelines for sustainable aquaculture and responsible practice will also contribute to greater recognition of aquaculture, particularly in terms of its benefits and of the diversity of practices and people involved.

It should be noted that other guidelines on the Code's Articles, including those issued on "Integration of Fisheries into Coastal Area Management[1]", "Fisheries Management[2]" and "Precautionary Approach to Capture Fisheries and Species Introductions[3]" are covering relevant aspects related to aquaculture, including culture-based fisheries. Additional relevant guidance material is under preparation or is being finalized, including:

- Technical Guidelines for Quarantine and Health Certification for Responsible Movement of Aquatic Organisms
- Technical Guidelines for Good Aquaculture Feed Manufacturing Practice
- A Framework for the Responsible Use of Introduced Species
- Code of Hygienic Practice for the Products of Aquaculture (being prepared within the framework of the FAO/WHO Codex Alimentarius Commission)
- Guidelines for Development and Management of Inland Fisheries
- Guidelines and Criteria for Responsible Enhancement Measures for Culture-based Fisheries
- Manual and Technical Guidelines for the Rehabilitation of Rivers and Improvement of Fish Habitats
- Guidelines on the Integration of Agriculture, Forestry and Fisheries into Coastal Management

1.2 Structure and content of this document

The document is organized following the structure of Article 9 ***Aquaculture Development*** of the Code of Conduct for Responsible Fisheries (from here onwards termed the "Code" or CCRF). Each principle is specifically addressed in order to provide the reader with related annotations containing suggestions and observations. Article 9 contains four sections, as developed during the preparation of the Code. The first section addresses issues to be considered primarily in areas under national jurisdiction. The second section deals with aspects which, while the prerogative of sovereign states, might affect other states. The third section covers issues relating to the use of aquatic genetic resources. Finally, questions to be considered at the production level are dealt with in the fourth section.

The principles, as adopted for Article 9 of the Code, are highlighted in bold. The annotations are supported with additional notes in boxes and selected references which may be useful in discussions and further follow-up work. References provided are numbered throughout the text, and can be found at the end of the document. Readers are

[1] Integration of fisheries into coastal area management. *FAO Technical Guidelines for Responsible Fisheries*. No. 3. Rome, FAO. 1996. 17p.

[2] Fisheries management. *FAO Technical Guidelines for Responsible Fisheries*. No. 4. Rome, FAO. 1997. 82p.

[3] Precautionary approach to capture fisheries and species introductions (FAO *Fish.Tech.Pap.*, 350/1), reissued as *FAO Technical Guidelines for Responsible Fisheries*. No. 2. Rome, FAO. 1996. 54p

encouraged to exchange with other interested persons any technical documentation, guidance material and information on experiences which may contribute to the implementation of actions required. Readers are also invited to send such information to FAO's Fisheries Department, and thereby contribute to the development, improvement and updating of guidelines being prepared in support of sustainable development of aquaculture.

1.3 Use of terms

Aquaculture:

Aquaculture is defined here according to the definition currently used by FAO for statistical purposes, i.e: - "Aquaculture is the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries."

Culture-based Fisheries:

The text also includes provisions for culture-based fisheries which are taken to mean capture fisheries which are maintained by stocking with material raised within aquaculture installations. However, this definition is too narrow to cover the range of management practices collectively known as enhancements, and for the purposes of this document the following ***working definition***[4] for culture-based fisheries is given as: - Activities aimed at supplementing or sustaining the recruitment of one or more aquatic species and raising the total production or the production of selected elements of a fishery beyond a level which is sustainable through natural processes. In this sense culture-based fisheries include enhancement measures which may take the form of: introduction of new species; stocking natural and artificial water bodies; fertilization; environmental engineering including habitat improvements and modification of water bodies; altering species composition including elimination of undesirable species, or constituting an artificial fauna of selected species; genetic modification of introduced species.

Food Security:

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (Reference 1).

[4] Definitions for culture-based fisheries will be discussed in further detail during the forthcoming FAO Expert Consultation on Fisheries Enhancements, to be held in April 1997 in Dhaka, Bangladesh.

Sustainable Development:

Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable. (Ref. **2**).

2. Responsible development of aquaculture, including culture-based fisheries, in areas under national jurisdiction *(CCRF Article 9.1)*

"States should establish, maintain and develop an appropriate legal and administrative framework which facilitates the development of responsible aquaculture."
(CCRF Article 9.1.1)

General responsibilities. In order to promote, support, and regulate an efficient and responsible aquaculture sector, States should establish, maintain and further develop an appropriate administrative and legal framework to ensure that responsible aquaculture practices are introduced and implemented within their national jurisdiction.

Box 1. *Government authorities are responsible for existing and future aquaculture developments, and in many countries will continue to play a major role in promoting and regulating aquaculture development. In many countries, for example, existing administrative and legal frameworks may need to be adjusted to address the specific characteristics and needs of the sector. Likewise, legal provisions and regulatory measures may need to be streamlined so as to clearly set forth the privileges and responsibilities of aquaculturists. Frequently, aquaculture is still under a general fisheries basic legislation, and is often not being recognized as the aquatic equivalent to agriculture. There is much scope for increasing awareness of both public institutions and the general public about aquaculture and its similarities with agriculture. This may be achieved through collaborative efforts by aquafarmers, authorities, media and non-governmental initiatives. This would contribute to the development, as appropriate, of laws and regulations which reflect awareness and recognition of aquaculture characteristics and needs.*

Designated authority. States should designate or establish an authority or authorities competent, empowered and capable to effectively promote, support and regulate aquaculture and culture-based fisheries. Appropriate institutional linkages with other authorities such as those concerned with agriculture, rural development, water resources, environment, health, education and training and many others, should also be established. These linkages may have to be expressed in legislative form.

Legal framework. States and their aquaculture authorities should ensure that the aquaculture sector is adequately regulated and protected by legal instruments such as laws, regulations, orders, agreements, etc. which set forth the responsibilities, rights and privileges of aquaculturists in a manner which is consistent with the current and potential aquaculture practices and with those applied to comparable activities. (Ref. 3, 4).

Understanding and enforcement of aquaculture legislation. States and their aquaculture authorities should ensure that all applicable legal instruments including laws, regulations, orders, etc. are conceived in such form as to be readily understood by those undertaking activities within the aquaculture sector, are adequately communicated to them, and finally that these legal instruments are enforceable and enforced. (Ref. **5, 6, 7**).

Box 2. *A Code of Practice ("soft law") may often suit best the purposes of regulating aquaculture practices, and may have an important role to play as a "regulatory instrument". When deciding between soft and hard law, it is useful to consider the nature of the essential purposes of the rules which are to be applied to the aquaculture activity, as well as to define clearly the needs to regulate and control the future "social conduct" of aquafarmers. In many cases it may be found that there is little need for such measures, but that there is a need to protect and promote aquaculture activities. Traditional forms of legal regulation which pursue rules enforced by communal and administrative penalties are generally not well suited to address all issues in aquaculture, in particular issues like product quality which require encouraging progressive involvement and adoption of appropriate measures rather than distinguishing between right and wrong (what's legal and illegal). Adherence to Codes may be problematic in that they are not enforceable but they are likely to be implemented by those concerned, given the moral weight they carry. However, when facilitating the formulation of soft or hard law measures, or combinations of these, it may prove very useful to ensure good collaboration between regulators and aquafarmers, based on involvement of aquafarmers during formulation, and recognition of their activity and needs. Consideration should also be given to potential problems which might result from "over-regulation" and overlapping or conflicting provisions.*

"States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information."
(CCRF Article 9.1.2)

General responsibilities. States should, through their competent authorities, and in partnership with all interested actors of civil society, promote development of environmentally sound and sustainable aquaculture well integrated into rural, agricultural and coastal developments, raise awareness of the general public of the benefits of aquaculture practices for enhanced food supply and income generation, and support efforts aiming at responsible actions of aquafarmers and all those concerned or associated with aquaculture. (Ref. **8, 9, 10, 11**).

Advance evaluations of genetic effects. Genetic effects may arise from the interaction of farmed species with wild species and can be caused by the use of introduced species and

by species that have been domesticated, or genetically modified by an aquaculture breeding programme or other technologies. Undesirable genetic effects may include:

- contamination of native gene pool through interspecific hybridization,
- degradation of native species through flux of exotic genes that are 'less fit' , either by means of hybridization or, hypothetically, by gene transfer,
- loss of native species, or change in species composition through competition, predation, or habitat degradation.

Advance evaluation of genetic effects should include a risk assessment that examines:

- the probability of an escape from the culture system,
- survival of the organism if it does escape,
- the organism's reproductive capability in the wild, both with itself and with other species,
- the ability of specific genes from the species to be transferred to native species.

An assessment of the potential damage should be made and, in essence, the key question is "does the organism present a danger to the ecosystem or to important species in the area ?" In relation to genetic technologies and risk, the change the technology imparts to the organism should be evaluated rather than the technology itself. If certain technologies such as gene transfer are associated with high levels of uncertainty as to their effect on the organism or the environment, then more testing, stricter regulation and monitoring should be followed.

Box 3. *For advance evaluation (i.e. pre-impact assessment) to have significant and practical meaning, there should be predetermined standards, i.e. acceptable limits of impacts. Present knowledge of many ecosystems and their genetic diversity is often very incomplete, especially in many developing countries and tropical regions. Setting standards for allowable genetic "effluent" is still very difficult, because of the scarcity of information on the effects of aquaculture/wild animal interaction, survival of aquaculture escapees, and their impact on ecosystems. These acceptable levels of impact will not only be necessary to make advance evaluation meaningful, but they may also serve as guidelines or benchmarks for the monitoring of the ensuing aquaculture development. The Precautionary Approach to Fisheries Management (*Ref.. **12)** *requires the establishment of such benchmarks, as well as contingency plans when acceptable levels are breached. Collaboration among environmental scientists, aquaculture experts and development planners will be required in many cases to successfully apply precautionary approaches and to implement advance evaluations. However, it should be noted that even the models available for the assessment and prediction of ecological impacts of aquaculture wastes are usually highly site-specific, often quite sophisticated, and, in most cases only applicable in temperate regions. Therefore, cost-effective and rapid assessment methods are needed which can be applied easily in tropical environments and developing countries. In general terms, environmental scientists can help by clearly distinguishing between actual and hypothetical environmental hazards resulting from aquaculture practice.*

"States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities."
(CCRF Article 9.1.3)

Aquaculture development and support planning. In many countries there is a continued need for aquaculture and planning authorities to produce and regularly update comprehensive plans for promoting, supporting, regulating, and reporting on the aquaculture sector. The plans should encompass all relevant aspects of support and management of the industry. (Ref. **13**, **14**, **15**, **16**, **17**, **18**). Given the possible contributions of aquaculture to enhanced food supply and rural development in many countries, it may be very useful to design aquaculture development plans with due consideration of existing plans and efforts aiming at food security, sustainable agriculture and rural development. (Ref. **19**, **20**).

Development planning will involve, possibly in consultation with all interest groups, the setting of policies and objectives, determining and implementing of actions required, monitoring the sector's performance, and adjusting the aquaculture development plan. Good collaboration among those concerned will help identifying the type of data and information necessary for monitoring and planning.

Box 4. *States are very diverse with respect to the natural resources available for different types of aquaculture, as well as in the degree of development of supporting infrastructure, the financial resources available to provide specialist advice, training and other support to the sector, and the strengths of local and regional markets. An aquaculture sector study will establish the status of the sector, its performance and trends, identify the opportunities and constraints within it, and identify options or strategies for its development. Based on the sector study, a strategy for the sector enables the government to define, or redefine, its objectives for the sector and shows how these objectives are to be met, prioritizes activities, and describes the range of policies and the policy instruments to be employed, such as the criteria for the allocation of land and water, institutional changes, promotion of appropriate technology use, etc. An aquaculture development plan will take the planning process a stage further by setting out in some detail the policy instruments to be employed, the financial, human and other resources required, and the time frame in which planned activities will take place.*

Ideally, an aquaculture development plan should reflect the responsibilities of all parties concerned, possibly in accordance with the principles and guidelines of the Code of Conduct for Responsible Fisheries. Clearly, an aquaculture development plan should also suit the needs of individual States while taking into account the social and economic conditions in which aquaculture practices are or will be carried out. Where appropriate, the

mechanisms for consultation of aquafarmers and other private sector representatives as well as the involvement of local authorities and communities could be further specified in aquaculture development plans, in particular with regard to their role in the implementation and enforcement of the Code's principles and guidelines.

Assuring appropriate and responsible use of land and water resources. It should be ensured by aquaculture and planning authorities as well as by aquaculturists and investors that aquaculture activities are sited in locations which: are suitable for sustainable production and income generation; are economically and socially appropriate; prevent or minimize conflicts with other users of resources, and do not create undue externalities; respect nature reserves, protected areas, and critical or especially sensitive habitats.

Government authorities should also ensure that the privileges and needs of the aquaculture sector are recognized and respected by other users of land and water and, in particular, that aquafarms are not exposed to external environmental threats resulting from activities in other sectors that reduce quality and quantity of water, nutrient and biological resources required. Where applicable, zoning or site regulations should be specified to conform with the requirements of plans for regional development, river basin or coastal area management, and their respective authorities. (Ref. **21, 22, 23**).

As generally done with agricultural and forestry activities, aquaculture and fishery enhancement practices should also be duly considered in planning and management of inland and coastal resources. (Ref. **24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39**). In many countries there is a need for collaboration and capacity building in many areas relevant to resource use planning for aquaculture development, including application of resource assessment and monitoring methodologies, cross-sectoral resource use planning and management, environmental accounting, and mechanisms for conflict resolution and involvement of stakeholders in decision-making processes. Those who have special responsibilities and skills with respect to the development of aquaculture and other sectors should work together for the sustainable use of resources, maximizing wherever possible their complementarities.

For example, when reviewing and implementing water resource use policies (Ref. **40**), it may well be worth considering benefits of existing and future aquaculture and inland fisheries developments. In particular, water allocation and pricing policies should address potential economic and social benefits of incorporating aquaculture and fishery enhancement practices. At the same time, most efforts aiming at the conservation of water resources and/or the protection of aquatic environments can and should be beneficial to fisheries and aquaculture, thereby increasing food security and generating some net economic gain for a local community, or in certain cases, a positive contribution to the economy of a given country.

Institutional capacity for the support of aquaculture. Primarily for historical reasons, the institutional frameworks used by States to develop and support their aquaculture sectors have usually grown out of their fishery, forestry or other natural resource institutions and organizations. While States may continue to find such arrangements practical, especially with respect to biological, marketing, and food quality aspects, they should also consider strengthening linkages with their institutions concerned with agriculture, rural

development, irrigation, engineering and other sectors with which aquaculture activities have much in common (Ref. **41**, **42**, **43**). In particular, collaboration between water development agencies and aquaculture and fishery administrations could be facilitated, which would help to identify common interests resulting in benefits to both sectors (Ref. **44**). Aquaculture and fishery experts should be involved in the formulation of economic and legal instruments relating to water management (Ref. **45**).

Promoting appropriate development and technology of aquaculture. It is the responsibility of every State to ensure that all development is appropriate, sustainable and in the public interest. Proposed aquaculture development activities are especially likely to be uncritically examined owing to the low level of experience in the sector in many countries. Government officials, in collaboration with aquaculture development experts, aquafarmers and aquaculture investors, should evaluate the possible benefits and consequences, including costs, of the introduction of new or different aquaculture products, methods or technologies to ascertain whether they are likely to contribute to increased food supply and rural development and/or to the economy and to the welfare of their citizens generally, or whether they may result in significant public burden such as abandoned capital investment, requirements for subsidy, or excessive demands on scarce or critical resources (land, water, feedstuffs) needed for more important products or activities. (Ref. **46**, **47**). In addition, government authorities and financial institutions concerned are encouraged to consider economic opportunity costs of aquaculture development and to assess whether the resources employed can be used with greater economic welfare elsewhere in the economy. Considerations of cost-effectiveness and benefit sharing can be instrumental in defining appropriate objectives of aquaculture development plans.

"States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments."
(CCRF Article 9.1.4)

Ensuring livelihood of local communities. Expanding food production in developing countries, particularly in low-income food deficit countries, can be one of the primary means to increase availability of food and income for those living in poverty. The livelihood of rural communities in inland and coastal areas of many countries depends on the capacity by the rural poor to produce food through a wide range of activities, which often include very diverse practices of terrestrial and aquatic farming, fishing and utilization of forest products. Aquaculture practices in most rural areas, and, increasingly also in peri-urban locations, have proven to contribute to enhanced and diversified food supply and income generation in most local communities. However, due consideration should be given to the need for all practices of food production to expand, intensify, specialize or diversify, in such a way that existing traditional practices are well integrated in such innovations (Ref. **48**).

Aquaculture for local communities. For aquaculture practices to develop sustainably, and for the general benefit of local communities, it is important for government authorities to facilitate collaboration and constructive dialogues between aquafarmers or aquaculture developers and other stakeholders in local communities (Ref. **49**). Access to

fishing grounds should be guaranteed and, where necessary, regulated for the mutual benefit of fisheries, culture-based fisheries and aquaculture. Agreements should be fostered between aquafarmers and fisherfolk, to avoid conflicts over access to shared resources such as water, space and living aquatic resources. Large-scale aquaculture developments should be preceded by social and economic assessments, in order to identify options for involvement and benefit sharing among members of local communities, and to ensure long-term economic viability of such developments.

"States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities."
(CCRF Article 9.1.5)

Ensuring acceptable levels of impact on the environment. Ideally, an information and management framework for the protection of inland and coastal environments and resources should be in place capable of detecting and predicting ecological changes resulting from all human activities in a given area. All environmental impact assessment and monitoring efforts should be guided by predetermined development priorities and well-formulated objectives for the management of resources and environments. (Ref. **50, 51, 52, 53**).

However, in the interest of other farmers and water users, and the public in general, government authorities should establish procedures to undertake appropriate environmental impact assessments prior to establishing aquaculture farms, and to ensure adequate monitoring of water extraction, effluents, use of drugs and chemicals, and other farm activities that might adversely affect the surrounding lands and waters. Provisions for obtaining baseline data and for monitoring should normally be established in conjunction with the procedures used to grant and review permits to engage in aquaculture on a particular site. Environmental assessment and monitoring is an important area for collaboration by authorities, researchers and aquafarmers. Consultations among all concerned should ensure that procedures for environmental impact assessment and monitoring are sufficiently flexible, taking into account that scale and cost of such efforts may well have to be adjusted to the scale of the perceived impact of a given aquaculture operation. Criteria should be defined to establish which procedures for environmental impact assessment and monitoring would be required from the aquafarmers, when considered necessary. Proposed methods for environmental assessment and monitoring should be evaluated for their applicability to local conditions and site characteristics. (Ref. **54, 55, 56, 57**).

Box 5. *When formulating programmes or requirements for environmental assessments and monitoring, due consideration should be given to the diversity of aquaculture practices (including, in particular, the species used and the culture methods applied) and their environmental settings. However, in many cases, particular emphasis will need to be given to simplicity, flexibility and affordability of environmental assessments and monitoring, in order to facilitate the acceptance and enforcement of such measures. Consultation and participation of interested and affected parties in the formulation of requirements for environmental assessment and monitoring should be encouraged. A detailed evaluation of financial, manpower and time requirements for any such effort should precede their implementation to demonstrate their cost-effectiveness and feasibility.*

3. Responsible development of aquaculture including culture-based fisheries within transboundary aquatic ecosystems *(CCRF Article 9.2)*

"States should protect transboundary aquatic ecosystems by supporting responsible aquaculture practices within their national jurisdiction and by cooperation in the promotion of sustainable aquaculture practices." ***(CCRF Article 9.2.1)***

Protecting transboundary aquatic ecosystems. Many river and lake basins, and their respective catchment areas, enclosed and semi-enclosed seas as well as other coastal and marine waters are being shared by two or more countries. Consequences of human activities such as habitat degradation and pollution of these waters are often being experienced within a given country as well as beyond its boundaries in downstream areas, along coasts or in larger inland and marine water bodies. For example, in many countries inland capture and culture-based fisheries have suffered from environmental degradation of perennial and seasonal water bodies. Changes in water quality, changes in hydrological regimes (excessive fluctuations or net decline of water levels/volumes both spatially and temporally), and structural modifications of fish habitats, have affected many inland fisheries, especially in rural areas where fishing at artisanal and subsistence levels often contributes to food security.

There are numerous international agreements in place, or being developed, aiming at the environmental protection of transboundary aquatic ecosystems (Ref. **58**). However, since some practices in aquaculture and culture-based fisheries may have potentially adverse effects on transboundary aquatic ecosystems, if not managed properly, it is important that government authorities, fishery managers and aquafarmers are aware of such potential risks.

For example, government authorities, aquafarmers and fishery managers have a special obligation to minimize the risks of introducing non-native species or genetically altered stocks used for aquaculture or culture-based fisheries into waters where there is a significant risk for spreading into the waters of other states. The accidental or intentional introduction of exotic or non-native species to any waters should be avoided to the extent possible, but when deemed desirable for purposes of aquaculture or fisheries enhancement, a thorough study of alternatives and potential risks should be undertaken prior to the introduction. In this context, precautionary attitudes and measures should be encouraged, whether for national or transboundary aquatic ecosystems, and collaboration, especially exchange of information, between countries concerned can be crucial to prevent undesirable impacts.

Support to and collaboration on sustainable aquaculture. While responsibilization of aquafarmers should be pursued at national levels, there is much scope for collaboration on sustainable aquaculture among countries sharing transboundary aquatic ecosystems, for example, at sub-regional or regional levels. Government authorities, private sector

associations, researchers, and others, in different countries may find it useful to join efforts in the promotion of sustainable aquaculture development. Such efforts could include technology development and transfer, development and implementation of contingency measures, exchange of marketing information, capacity building in the aquaculture sector, applied research on socio-economic and environmental issues, etc. (Ref. **59, 60, 61, 62, 63, 64, 65**).

"States should, with due respect to their neighbouring States, and in accordance with international law, ensure responsible choice of species, siting and management of aquaculture activities which could affect transboundary aquatic ecosystems."
(CCRF Article 9.2.2)

General Responsibilities. States with aquaculture activities in or bordering international waters should accept the obligation to their neighbouring States to ensure responsible choice of species, siting and management of those activities.

Choice of species. Choice of species for aquaculture and culture-based fisheries should be based on biological, environmental and socio-economic criteria, depending on local resources, opportunities and needs. Culture-based fisheries deserve special attention because the purpose of aquaculture is to produce an organism that survives in nature. However, it should be noted that even in contained aquaculture systems, organisms generally escape into the environment.

Several fora have recommended the use of native species over introduced species and the use of conventional breeding programmes over the use of trans-genic technologies for aquaculture. Governments should be aware of the biological resources and the human communities that depend on them that may be impacted by the use of an introduced or genetically modified organism. Probable or potential routes of dispersion should also be known for aquatic species.

Surveying distribution of introduced species. Once a species has been introduced into a country, national efforts should be made to control or monitor its distribution. There may be environmentally sensitive areas where the species should not be allowed to be cultured or areas where there would be a high probability of the species escaping into transboundary waters. These areas should be identified and local governments, aquafarmers, and the industry should be made aware of the restrictions governing movement and use. These considerations and restrictions should be part of the prior evaluation and risk assessment.

Siting and management. Governments should ensure that aquafarms are sited and managed such that adverse effects on environments and resources of other States are avoided. Particular care should be taken to prevent disease outbreaks associated with aquaculture species which may affect fisheries resources and aquaculture operations in other States. Governments should inform each other in the event of outbreaks of epizootic diseases in aquaculture species which are likely to be transmitted throughout

transboundary ecosystems, and collaborate on the development of relevant contingency measures at sub-regional and regional levels.

"States should consult with their neighbouring States, as appropriate, before introducing non-indigenous species into transboundary aquatic ecosystems." ***(CCRF Article 9.2.3)***

Role of regional fisheries bodies. Neighbouring countries should seek to establish effective mechanisms and procedures for consultation on introductions of non-indigenous species. However, in many areas with shared water bodies regional fisheries bodies exist and provide excellent fora for the exchange of information, expertise and personnel. Where no regional body or arrangement exists, there exists the potential to create one (Ref. **66**). Consultation on the introduction of genetically modified organisms should also be pursued. The definition of "non-indigenous", in broadest sense of the term, should include organisms that are the product of domestication, selective breeding, chromosome manipulation, hybridization, sex-reversal, and gene transfer. Items for consultation and exchange among neighbouring states should include, inter alia,

- species, its country(ies) or area of origin, and number to be introduced
- breeding programme or genetic modification used on the organism
- location of aquaculture site and possible routes of dispersion
- anticipated benefits
- anticipated and potential problems
- monitoring programme
- contingency plan
- reporting introduction to FAO for inclusion in databases.

"States should establish appropriate mechanisms, such as databases and information networks to collect, share and disseminate data related to their aquaculture activities to facilitate cooperation on planning for aquaculture development at the national, subregional, regional and global level." ***(CCRF Article 9.2.4)***

Information sharing in aquaculture. Especially during this period of global growth in aquaculture, States, in collaboration with interested partners, should develop appropriate means to monitor their aquaculture activities, and also to facilitate policy formulation and development planning, through the collection of information and data relating to their aquaculture farming practices and production, their economic performance and their positive and negative effects on other activities. Collaboration with, and among aquafarmers, their associations, input suppliers, product processors and traders, and other private initiatives interested in the aquaculture sector, may need to be further strengthened, in order to improve data acquisition and collection as well as collation, analysis, interpretation, dissemination and appropriate use of information and data (Ref. **67**). Importantly, in many countries there is an urgent need to strengthen or develop appropriate library services. The flow of information relevant to aquaculture among

various sectoral agencies and authorities, whether primarily or partly concerned with aquaculture development aspects, can be facilitated through adequate institutional linkages. Acting through the appropriate regional and international bodies of which they are members, States should share relevant data to permit regional and global monitoring of progress and problems, facilitate policy making, and permit forecasting of opportunities and needs. (Ref. **68**).

Box 6. *Users of aquaculture data and information are diverse in nature and include, for example, aquafarmers, policy makers, researchers, those working in the food sector and animal feed and health industries, concerned NGOs, those concerned with food security, development and resource planning, etc. The demand for global, regional and national aquaculture data is growing rapidly. In addition to production statistics there is a need for data on structural aspects of the sector such as areas under cultivation, types and capacities of production systems, resource use (e.g. land, water, feed components, seed, etc.), and employment in the aquaculture sector and its allied services. Also growing is the strong interest in information on domestic and international demand for aquaculture products, including consumption patterns, product prices, trade, market opportunities, etc.*

Regional cooperation in the exchange of aquaculture knowledge. Efforts should be supported by governmental and other institutions or initiatives to enhance cooperation, especially at regional and sub-regional levels, in capacity building and research on aquaculture systems most suitable to their regions, and in the elaboration of mechanisms and protocols for the exchange of knowledge, experience and technical assistance in support of sustainable development of those systems. (Ref. **69, 70, 71, 72, 73, 74**).

"States should cooperate in the development of appropriate mechanisms, when required, to monitor the impacts of inputs used in aquaculture."
(CCRF Article 9.2.5)

Collaboration on fair trade in equipment, feeds, and other inputs used in aquaculture. Owing to the somewhat specialized requirements of aquaculture for equipment and supplies, and the limited quantities presently needed or available in several regions, there is a need for enhanced cooperation in establishing production facilities, and for promotion of trade in such equipment and supplies within and between regions. At the same time, adequate regulatory mechanisms should be put in place to monitor and guarantee the appropriateness and quality of materials produced and traded. Related measures designed to protect human or aquatic life or health, and the interests of consumers, should not be discriminatory and should be in accordance with internationally agreed trade rules, in particular the principles, rights and obligations established in the WTO Agreement. Access to and exchange of information on effectiveness and safety of inputs used in aquaculture should be facilitated at local, national, regional and global level.

Box 7. *States and their authorities have a key role to play in identifying and supporting sound aquaculture production approaches, and should, for these purposes, collaborate with other States and international institutions and initiatives. However, sometimes there is uncertainty about sound criteria for appropriateness of imported technology and for efficient utilization of equipment, feeds and other inputs. The use of high technology systems for either seed production or growout, self-contained production "packages" or "turn-key units", or unfamiliar species or other unfamiliar components, in some cases have been found to be prone to failure. If a probable need to import replacement parts, supplies or expertise to maintain such systems is identified, these may be unsustainable in the long-term. Importantly, the use of non-native species for culture should be examined very carefully, but may be justifiable, for example, if likely to contribute to food security; this would require that they are readily marketable, their culture in locally appropriate farming systems is well understood, and that there are no suitable native species or varieties.*

4. Use of aquatic genetic resources for the purposes of aquaculture including culture-based fisheries *(CCRF Article 9.3)*

"States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin. States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escaped farmed fish on wild stocks."
(CCRF Article 9.3.1)

Maintaining genetic diversity by management. Aquaculture practices can affect genetic diversity at the species, community, ecosystem and landscape levels. In fact aquaculture is designed to change the landscape or ecosystem to one that is more productive. Management to protect aquatic genetic resources involves risk assessment and monitoring (Ref. 75), as laid out before, and should involve documentation of "wild" genetic resources to establish a benchmark for assessing impact. Efforts should be made to document the genetic resources utilized in aquaculture as well as to compile information on natural aquatic genetic resources. Information bases may need to be established on aquatic genetic resources and their distribution, including both farmed and wild aquatic species. Further, aquaculture stocks or stocks for culture-based fisheries can be managed within the culture facility:

- to avoid inbreeding,
- maintain stock integrity by not hybridizing different stocks, strains, or species,
- by minimizing transfer of genetically different stocks (see below), and
- by periodic assessment of their genetic diversity (i.e. laboratory genetic analysis).

Natural levels of genetic diversity can be maintained by reducing the movement of genetically diverse populations within a country. That is, egg/fingerling/adult transfers among river basins or large water bodies should be avoided if possible. Hatcheries have a history of egg transfers over large distances and there is evidence that many of these transfers do not perform as well as local stocks when released into the new environment. This is most important in culture-based fisheries. In contained growing situations the mixing of genetically diverse stocks often leads to improved culture performance. However, in the case of inter-specific hybrids, the improvement may only be found in the first generation cross and not in subsequent breeding of the hybrid population.

Genetic technologies can also be used to reduce the risk of the genetic impacts of farmed stocks on wild stocks. For example, culture of non-reproductive animals (e.g. sterile, triploid or mono-sex populations of organisms) will reduce the chance of the organism breeding in the wild. Public education on the safety and ethics of genetic technologies may be required to ensure consumer acceptance of aquaculture products.

Native species are often promoted as an alternative to introducing exotic species for aquaculture development. Often exotic species are preferable from an economic point of view (i.e. better price, export potential, etc.) and local species may not be domesticated. Native species may be preferred locally, may have less chance of introducing disease, and may grow better under local conditions. However, native species taken from the wild and domesticated or subjected to other genetic modifications may also pose a risk to the remaining wild stocks, both from genetic and disease standpoints.

Box 8. *Several mechanisms exist to regulate the use of genetically modified organisms and introduced species in aquaculture. For introduced species the ICES/EIFAC Code of Practice (Ref. 76, 77), the Nuisance Species Protection Act (USA; Ref. 78) as well as national legislation in many countries govern the use and transport of species outside of their natural range. For genetically modified organisms (GMOs), the Directives of the European Union (Ref. 79), Performance Standards of the USDA (Ref. 80) as well as the ICES Code of Practice govern their use, transport, and release into the environment. The Convention on Biological Diversity is mandated to draft biosafety protocols for the safe use of genetically modified organisms (primarily plants at this stage), and until such protocols are negotiated, UNEP International Technical Guidelines for Safety in Biotechnology have been recommended by the Convention's Conference of the Parties (Ref. 81).*
Databases on international introductions of aquatic animals (Ref.82) and aquatic animal pathogens (Ref. 83) are sources of information that can be consulted to help determine what risks a proposed introduction may entail. These databases are continuously being updated and expanded.

"States should cooperate in the elaboration, adoption and implementation of international codes of practice and procedures for introductions and transfers of aquatic organisms."
(CCRF Article 9.3.2)

International codes of practice and procedures. Several international codes of practice concerning the use of introduced species and genetically modified organisms exist and have been adopted in various forms by the international community. These codes represent one of the best means to protect the aquatic environment and their associated human communities. These codes of practice have been produced in developed

countries of temperate latitudes. There is a need to adapt these to the developing and rural areas of the world. Basic elements of codes of practice such as ICES include:

- a proposal to introduce a particular species in a particular area for a particular purpose,
- an independent review of the proposal by competent authority, the review should include ecological and socio-economic risk assessments
- rejection, revision, or acceptance of the proposal,

Once an introduction has been approved governments should request aquaculturists to:

- create a fish health management programme including quarantine and disease diagnosis,
- monitor and evaluate ecosystem and socio-economic effects
- notification of international organizations and neighbouring States.

A country's ability to carry out the elements of the code will depend on the state of knowledge, on its human and aquatic communities and on the financial and human resources available. Faunistic and floristic surveys of local aquatic ecosystems can help determine what local species may be affected by aquaculture development and what local species may be utilized instead of importing an exotic species. Socio-economic information on the fishing sector and on the fish-consumers will also help identify those people benefiting or at risk from aquaculture development. In addition, marketing surveys can help determine the cost-effectiveness and target consumer for a proposed introduction.

"States should, in order to minimize risks of disease transfer and other adverse effects on wild and cultured stocks, encourage adoption of appropriate practices in the genetic improvement of broodstocks, the introduction of non-native species, and in the production, sale and transport of eggs, larvae or fry, broodstock or other live materials. States should facilitate the preparation and implementation of appropriate national codes of practice and procedures to this effect."
(CCRF Article 9.3.3)

Guaranteeing quality, performance and ecological safety of seed and broodstock. States and their aquaculture authorities should promote responsible practice in the genetic improvement of broodstocks, and in the production, sale and transport of eggs, larvae or fry, broodstock or other live materials. Sound hatchery practices are needed to avoid deformities or other genetic problems resulting from excessive inbreeding while allowing genetic improvement. They also are essential to minimize the spread of diseases (Ref. **84**, **85**, **86**). Where wild seed stock is collected and distributed, particular care is required to ensure that other species are not mixed with the desired stock. (Ref. **87**). States should develop guidelines or regulations, as appropriate, on what are acceptable genetic technologies and breeding practices. For example, some States prohibit the unauthorized hybridization between species; many States restrict the production of trans-genic

organisms, whereas some impose strict regulations on the hatchery and culture facilities that are raising trans-genics (Ref. **88**). The international codes of practice mentioned above may provide a framework for the development of national guidelines and procedures. As stated before, States should regulate the use and transport of aquacultured species within their borders.

"States should promote the use of appropriate procedures for the selection of broodstock and the production of eggs, larvae and fry."
(CCRF Article 9.3.4)

Selection of broodstock. Selection of broodstock should be based on, *inter alia*, the performance of the fish in culture, the desired breeding programme, the genetic profile of the broodstock, and economic and environmental considerations. Production of eggs, larvae and fry will depend upon sound hatchery and growout management, after selection of appropriate broodstock.

Breeding and genetic improvement. While considerable improvements have been made in cultured stocks through genetic selection and breeding programmes, few fish farmers have the required training and experience to do such work efficiently and without significant losses of genetic fitness. For such reasons it is advisable to establish specialized facilities for the development of improved stocks and the production of seed. Where this is not practicable, farmers should try to keep genetic diversity high (Ref. **89**):

- by breeding as many fish as possible,
- by using brooders and eggs from the entire spawning season,
- by avoiding full-sib or parent-offspring matings, and
- by keeping careful records on production parameters.

Decreased hatchability, decreased fertility, increased deformities, increased disease and decreased survival may be signs of inbreeding and loss of genetic diversity. They may be signs of other problems as well and this is why good records are necessary to determine the most probable cause(s) of the problem. Where feasible, States should also require that breeding history and disease history be maintained for aquaculture stocks. This will facilitate exchange of broodstock and seed within the country and will provide valuable information to be considered if a species is to be exported.

"States should, where appropriate, promote research and, when feasible, the development of culture techniques for endangered species to protect, rehabilitate and enhance their stocks, taking into account the critical need to conserve genetic diversity of endangered species."
(CCRF Article 9.3.5)

Safeguarding endangered species. Aquaculture practices may contribute to the protection and enhancement of stocks of endangered species. States should carefully consider the provision of support to the development of appropriate culture techniques for endangered

species. The use of hatcheries and aquaculture facilities for the temporary protection and breeding of endangered species is considered to be a valuable facet of *ex situ* conservation. While such *ex situ* conservation is often necessary in the face of immediate environmental threat and the potential loss of valuable species or genetic resources, the preferred method for endangered species protection is *in situ*, i.e. habitat rehabilitation and the amelioration of the threat to the species.

Breeding of endangered species. The purpose of an endangered species breeding programme is to produce an organism that can be released into nature once the threat to its survival has been alleviated (Ref. **90**). Breeding efforts should try to optimize the natural genetic variability in the species:

- by using as large a breeding population as possible (increase effective population size),
- by avoiding inbreeding,
- by avoiding hybridization (unless sufficient broodstock of both sexes is not available), and
- by avoiding "domestication selection"; that is, avoid producing an organism that is adapted to the hatchery instead of nature.

Genetic technologies can be utilized:

- to identify genetically compatible or appropriate broodstock
- to determine the taxonomic status of an endangered species
- to reconstruct a population of males and females of an endangered species using gametes from one sex of the endangered species and a modified gamete of the other sex from a closely related, and presumably non-endangered, species
- to ensure a ready supply of gametes with cryopreservation of sperm from endangered or closely related species (above).

Where feasible and known, species that are in imminent danger of becoming endangered should be studied and managed to reduce the threat in their natural habitat. As a safeguard, sperm or live individuals could be conserved *ex situ* while management efforts to improve their chances of survival in nature are underway. The collection of species for this *ex situ* conservation should not threaten the viability of the natural population.

5. Responsible aquaculture at the production level *(CCRF Article 9.4)*

"States should promote responsible aquaculture practices in support of rural communities, producer organizations and fish farmers." *(CCRF Article 9.4.1)*

Promoting aquaculture development. Given the significant growth in production and value, and expansion of aquaculture and aquaculture-related activities, it is generally believed that aquaculture and culture-based fisheries hold much promise for meeting increasing food demands. In fact, aquaculture is overwhelmingly concentrated in the developing world, especially in Asian countries, providing important nutritional and economic benefits to rural communities, and, with few, if any, adverse environmental effects being experienced with low-input systems that make up the bulk of aquaculture production. (Ref. **91, 92, 93**). Exports of high-value species earn much needed foreign currency in many developing countries. More importantly for food security, the production, processing and sale of fish offer the prospects of improved nutrition in rural and urban areas by providing a ready source of affordable high-quality protein as well as giving an opportunity to generate income, while diversifying production and reducing risks of relying on production of one or few types of products only.

Promoting responsible practices and attitudes. The trends within many countries toward the use of more intensive aquaculture systems and more higher-value species often in sensitive coastal areas could increase the potential for environmental damage and may put additional stress on the socio-economic structure of local communities, if sustainable development approaches are not adopted. Therefore, it is essential that the aquaculture industry and all the stakeholders involved adopt a strong commitment for cooperation and self-regulation. It is the responsibility of States to support individual aquafarmers and the aquaculture industry in general in developing its own standards for responsible aquaculture practices. Where not existing, States should promote the establishment of self-help aquafarmer groups and producer associations, and foster the collaboration between the private aquaculture sector and government authorities, research institutions and other food producer organizations, at local, national and international levels. In doing so, government authorities should generate awareness on the need for responsible attitudes in the aquaculture sector, given the fact that, increasingly, aquafarmers and those associated with aquaculture are being made accountable for their actions. Consultations on possible incentives for the promotion of sustainable practices, may be held involving government authorities, aquaculture producers and members of rural communities. Training on regulatory aspects governing aquaculture practice should be provided to aquafarmers and their associations, to enable them to participate in the formulation and improvement of aquaculture-specific legislation.

Benefits of association and self-regulation. Major benefits which can be derived from association in producer organizations and the development of voluntary codes of practice and guidelines are (Ref. **94**):

- aquaculturists, associated by agreement on common standards and objectives, are in a better position to defend their interests, and to negotiate for rights and privileges against competing interests;
- public image of the aquaculture sector can be improved through adherence to established norms and adequate self-regulation;
- there will be greater common understanding and agreement on specific measures which can or should be implemented to ensure sustainable development of aquaculture;
- roles and responsibilities of persons, interest groups or institutions, public or private, can be identified and negotiated, with a view to assure and confirm their commitment and contribution to sustainable development of aquaculture; and
- as part of integrated area management, responsible aquaculture acknowledges its interaction with other sectors in the conservation and efficient use of resources and, therefore, can request that those sectors do not compromise the availability of resources of adequate quantity and quality required by aquaculture and fisheries.

"States should promote active participation of fishfarmers and their communities in the development of responsible aquaculture management practices."
(CCRF Article 9.4.2)

Enabling participation. Government officials, in collaboration with experts in aquaculture and rural development, and other relevant fields, should seek to promote, at both national and community levels, the active participation of individual farmers and producer organizations in the development and management of all existing and future aquaculture practices. This in order to ensure that the aquaculture practices selected, promoted and improved meet the general needs of local communities as well as the environmental conditions of given sites. Advice by experienced aquafarmers can be important for the selection of appropriate sites, species and systems, as well as for decisions for design, maintenance and operation of aquafarms, and should be considered in conjunction with area and site surveys, and, where appropriate, development of geographical information systems, when planning for resource uses in coastal and inland areas. Likewise, interests and needs of local communities should be identified when planning for sectoral, integrated or participatory developments, possibly by using appropriate rural and participatory assessment tools. (Ref. **95, 96, 97**).

Participation in research. Research efforts for aquaculture should aim at improved aquafarming methods, with a clear focus on the development of sustainable aquaculture systems, bearing in mind the need for increased food supply and poverty eradication. Renewed efforts should be made to involve aquatic and terrestrial farmers, their organizations as well as their communities, in setting research priorities and directions, including specific objectives and needs for particular research projects, and to make research findings accessible to them. (Ref. **98, 99, 100**).

Training, extension and capacity building at farm level. Rural areas in many developing countries are generally poorly equipped in terms of technical and financial resources and educational infrastructure, and serious food security and other economic and social

problems can result from lack of income opportunities, failure to crop and to maintain production systems, inadequate distribution of commodities, inputs and consumer goods, and limited access to public services. Appropriate and up-to-date technologies in both terrestrial and aquatic farming are required to promote modernization of local production methods. Full benefit from such technologies would require training, education and skill development programmes for local human resources. States should try to establish ways to assist farmers and local communities with extension, training, and other local capacity building activities. When these activities are small-scale and at some distance from urban centres, the provision of such assistance has proved difficult and costly. Relevant aquaculture authorities, aquafarmers and their communities may find it useful to collaborate closely in extension work with agricultural extension programmes in their areas, as these may be better equipped and have larger numbers of staff available. (Ref. **101, 102, 103, 104, 105, 106**).

Labelling of inputs used in aquaculture. States may have a key role to play in ensuring that inputs such as equipment, feedstuffs, chemicals, etc., utilized by aquafarmers are properly labelled, and that other important information on such inputs is accessible to them and their communities. Local languages and illiteracy should be considered.

Record keeping. In the interest of efficiency in operation and effective accumulation of experience in management of hatcheries, aquafarms and water bodies utilized for enhanced fish production, records should be maintained on the quantities and origin of all inputs (including species or strains) used, harvests and sales, and other operational and financial data. Such records are valuable in case of disease outbreaks or accidents to stocks or workers, and in understanding if and where mistakes were made. Further, they may be vital in defending the operation against any claims by outsiders of mismanagement or irresponsible actions.

Stress management and fish health maintenance. Incidence and severity of infectious disease are very often dependent on the quality of the environment in which the organism lives. Thus, the first and most important step in controlling infectious disease is by maintaining the best quality environment possible in the culture unit to minimize stress on the organism under culture. Stress in fish can be defined as the alteration of one or more physiological variables to the point that survival may be impaired in the long-term. Such alterations often result from changes in the physico-chemical, biological, and microbial quality of the aquatic environment, and the feed and space availability. Stress can be reduced by maintaining realistic stocking densities and providing best possible culture conditions. Reduction in stress will minimize the potential risk of becoming infected and thus reducing mortality and related losses. Collaboration on fish health management aspects among farmers, extensionists, and fish health experts should be promoted to increase awareness and capacity on fish health maintenance and farm management efficiency (Ref. **107, 108, 109**).

Interactions with predatory wildlife. Wild predators, particularly birds and aquatic mammals, can be a significant problem to aquaculturists, not only by consuming stock, but also by damaging nets and other equipment and transferring diseases and pathogens. Farmers should be encouraged to use all feasible means to shield their stocks from predators rather than attempting to destroy them.

Environmental management for enhancement of fishery yields. In order to increase fish supply in many rural areas, a wide range of techniques is being employed successfully to maintain and increase fish harvests particularly in many inland water bodies. Many fisheries have been intensified, through the provision of stocking material produced in aquaculture installations or collected from the wild, and through combinations of ecological, chemical and physical modifications of natural and artificial water bodies utilized. (Ref. **110, 111, 112, 113, 114, 115, 116, 117, 118**).

Given that such intensification measures can significantly contribute to additional food supply, and long-term food security, - in many countries there are numerous under- or non-utilized water bodies with high potential for culture-based and/or enhanced fish production - , it should be ensured that such practices are carried out in a well-planned manner. In this context, it is important that benefits and costs of such practices are evaluated, that rights are established for all those utilizing such water bodies, and that unacceptable effects on local environments and resources are avoided. Involvement of local stakeholders and communities in planning and management for the sustainable utilization of water bodies should be promoted, also in view of possible additional benefits which can be derived from activities aiming at recreation, and rehabilitation of aquatic environments.

"States should promote efforts which improve selection and use of appropriate feeds, feed additives and fertilizers, including manures."
(CCRF Article 9.4.3)

Selection and use of feeds and additives. The responsible use of feeds (including feed additives, where necessary) contributes both to efficient production and reduced impacts on the environment by minimizing wastage. Feed manufacturers and suppliers have a responsibility to provide appropriate quality feeds, and to assist farmers in managing and presenting these feeds on-farm in ways which facilitate efficient and optimum uptake by the stock. In many cases, supplementary feeds can be used in addition to factory-made feeds, and the use of locally available ingredients should be promoted, whenever possible. Responsible use of feed additives, including antibiotics and growth promotants, requires particular care in adjusting the quantities and rates of delivery to obtain the desired effects with minimum wastage, as well as paying close attention to withdrawal periods to ensure products which are free of possible contaminants. Wherever possible, the use of antibiotics in feeds (if at all) should be carried out only with veterinary (or equivalent qualified officer) prescription and supervision. (Ref. **119, 120, 121**).

Selection and use of manures and fertilizers. Some culture activities, such as seaweed culture and the pond culture of herbivorous or planktivorous fish and crustaceans, use manures or chemical fertilizers to improve the production of natural foods in the ponds. In order to avoid unacceptable changes in the receiving waters as well as maintain water quality in the production ponds and minimize input costs, fertilizing should be carefully controlled by the farmer. The responsible use of animal and human manures can contribute to efficient and safe recycling of nutrients within semi-intensive/extensive pond-based farming systems. However, the use of animal and human manures must be

managed carefully to avoid contamination of the product with human pathogens, parasites, heavy metals, antibiotics and other substances potentially harmful to consumers. (Ref. **122, 123, 124, 125**).

"States should promote effective farm and fish health management practices favouring hygienic measures and vaccines. Safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals should be ensured."
(CCRF Article 9.4.4)

Use of drugs, antibiotics or other chemicals to control disease. An adequate range of tested and approved materials to treat aquatic disease problems should be available to fish producers, and guidelines and training in their responsible use should be available. Preferably use of such materials should be under veterinary (or equivalent qualified officer) supervision, and the marketing and use of drugs which have not been certified for aquatic use should be strictly regulated, if not prohibited. To ensure maximum and continuing effectiveness of antibiotics, both for use in aquatic farming and especially for treatment of human disease, preventative (prophylactic) use of such materials should be avoided as far as possible. (Ref. **126, 127, 128, 129, 130**).

Box 9. *Because of limited markets and the high costs of testing and gaining approval of relevant authorities, few drugs have been tested and certified specifically for aquaculture use. The misapplication of some chemicals (e.g. the excessive prophylactic use of antibiotics) is often due to aquafarmers lacking access to information on appropriate use, or due to the lack of effective yet economic viable alternative management measures or suitable alternative chemicals which would help reduce the use of some potentially hazardous chemicals. At present the promotion of certain chemicals by "middlemen" (salesmen, retailers, etc.) or pharmaceutical companies may also play a significant role in the misapplication of chemicals.*

Use of hormones for controlling reproduction or as growth promoters. Hormones are sometimes being used in some forms of aquaculture practices for inducing or preventing reproductive maturation, for sex reversal and for promoting growth. While hormones may be widely used in animal husbandry, their use in aquaculture is not well documented and sometimes carried out without adequate understanding of the quantities needed and of their persistence in the environment or in aquaculture products once treatment is removed. Although the use of hormones for regulating reproduction is unlikely to result in contamination of stock destined for the market, when used as growth promoters, such use should be fully documented, and withdrawal times prior to harvest should be carefully observed.

"States should regulate the use of chemical inputs in aquaculture which are hazardous to human health and the environment."
(CCRF Article 9.4.5)

Regulating the use of chemicals in aquaculture. In order to promote and regulate the safe and effective use of chemicals in aquaculture, competent government authorities should work together to clarify and specify relevant mandates and responsibilities of various line agencies in charge of public health and food quality, agriculture, animal health services, environment, etc., and develop enforceable and practical aquaculture-specific provisions and guidelines on the responsible use of chemicals. Collaboration between aquafarmers, researchers and pharmaceutical and pesticide manufacturing industries should be promoted, to allow for testing and licensing of chemicals for use in aquaculture, as well as for formulation of sound and effective regulatory instruments on the production, distribution and use of chemicals which are known to be hazardous to human health and environment.

"States should require that the disposal of wastes such as offal, sludge, dead or diseased fish, excess veterinary drugs and other hazardous chemical inputs does not constitute a hazard to human health and the environment."
(CCRF Article 9.4.6)

Safe disposal of fish and chemical waste. Offal which is fit for hygienically acceptable processing should be so used. Other offal, dead fish and other waste that may be hazardous either to the aquaculture establishment or the public should be disposed of in appropriately designed facilities, approved by the relevant supervisory agency. Sometimes, cremation or burial may be an adequate method in the case of animal carcasses or parts of these. If treatment is not feasible or successful, diseased and dying fish should be humanely killed and disposed off safely. Different facilities are required for the disposal of unused or expired pesticides or veterinary drugs, and if not available on farm, such materials should be transported to licensed sites for disposal.

"States should ensure the food safety of aquaculture products and promote efforts which maintain product quality and improve their value through particular care before and during harvesting and on-site processing and in storage and transport of the products."
(CCRF Article 9.4.7)

Harvesting and product quality. A good quality product is not only a responsibility of the producer, but is an important factor in long-term financial profitability and growth. Good farmers and farm managers know that product quality depends on proper management throughout the entire production cycle. Nevertheless, particular care is necessary in the period leading up to harvest, in harvesting and on-site processing, and in storage and transport of the products. Prior to harvesting, it is important that the stocks have been freed from any residual drugs or hormones used, and their digestive tracts freed of algal or other materials that produce off-flavours. Harvesting should be carried out quickly and

efficiently, to minimize damage or contamination. Availability of adequate storage facilities and/or immediate transport should be ensured before harvesting is started. (Ref. **131**).

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Aquaculture is one of the fastest-growing food production systems in the world, and the bulk of its output is currently produced in developing countries. Most aquaculture practices have conferred significant nutritional and social benefits, generally with little or no environmental costs. In efforts to promote the future success of aquaculture in both developing and developed countries, it is essential that potential social and environmental problems be addressed to ensure that aquaculture develops sustainably. This document provides annotations to the principles of Article 9 of the Code of Conduct for Responsible Fisheries. These annotations are meant to serve as general guidance for those interested in identifying their own criteria and options for actions, as well as partners for collaboration, in support of sustainable aquaculture development. Commitment to collaboration, constructive dialogue among responsible partners and participation of aquaculturists and their communities are important in assigning responsibilities for sustainable development of aquaculture. Providing an enabling environment for sustainable development of aquaculture is the responsibility of government, social and natural scientists, the media, financial institutions and special interest groups (including social and private-sector associations) as well as aquaculture producers, manufacturers and suppliers of inputs, processors and traders of aquaculture products.

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